REMARKS

Disposition of Claims

Upon entry of the foregoing amendments, claims 1 and 3-11 will remain pending in the application and stand ready for further action on the merits. Claim 1 has been amended herein to recite that the composition comprises a thermally-conductive filler material having an aspect ratio of less than 5:1 in an amount of between 1 and 10 percent by volume. This amendment is fully supported by the specification particularly at Paragraphs 11-12, 36, and 46-47 and the originally filed claims. Claim 9 has been amended to recite that the third filler is spheroid in shape. This amendment is fully supported by the specification particularly at Paragraph 52. No new matter has been added to the application. Claims 3-11 are dependent on amended claim 1. Claim 2 has been canceled without prejudice or disclaimer of the subject matter contained therein.

Rejections Under 35 U.S.C. §112

The Office Action states that claims 1-11 are rejected under 35 U.S.C. §112, second paragraph as being indefinite, because of the recited terms, "PITCH-based carbon" and "PAN-based carbon." The Office Action further alleges that the abbreviated term, "PAN" is indefinite and the full chemical name should be used. The Office Action also notes that the terms, "said second third filler" and "said third filler" in dependent claims 9-11 lack antecedent basis.

In reply, Applicants submit that the term, "PITCH-based carbon" is a term commonly used in the art to refer to carbon materials made from carbonaceous pitch and "PAN-based carbon" is a term commonly used in the art to refer to carbon materials made from polyacrylonitrile. For example, U.S. Patent 5,037,590 describes this classification of carbon fibers:

> Carbon fibers are classified into two classes of so-called PAN-based ones and pitch-based ones depending on the starting material for the preparation thereof. The PAN-based carbon fibers are prepared from polyacrylonitrile fibers as the starting material and characterized by their high tensile strength and intermediate elastic modulus. For example, PAN-based carbon fibers may have an elastic modulus of

> about 400 GPa at the highest after a heat treatment at 2000°C. or above. PAN-based carbon fibers, however, have disadvantages that it is an inherently difficult matter that they are imparted with an extremely high elastic modulus because PAN-based carbon fibers are poorly graphitizable so that the degree of graphitization cannot be high enough in addition to the relatively high costs as compared with pitch-based carbon fibers.
>
> On the other hand, pitch-based carbon fibers are economically advantageous in respect of the low costs because the starting material thereof is an inexpensive carbonaceous pitch. (Col. 1, lines 19-38).

In view of the foregoing, Applicants believe that "PITCH-based carbon" and "PAN-based carbon" clearly define two very different carbon materials. PITCH-based carbon and PAN-based carbon are separate and distinct ingredients that are dispersed within the base polymer matrix in accordance with the present invention.

Applicants have amended claim1 to substitute the full chemical name, "polyacrylonitrile" in place of "PAN" as requested by the Examiner. The specification also has been amended to further clarify that "PAN-based carbon" means polyacrylonitrile -based carbon. It is submitted that no new matter has been added to the application.

Concerning claims 9-11, Applicants have amended claim 9 to clarify that the third filler is spheroid in shape as discussed at Paragraph 52 in the specification. Claim 1 has been amended to specify that the composition comprises a third filler of a thermally-conductive material as discussed in more detail below. Thus, the term, "third filler" in claims 10 and 11 now has antecedent basis.

In view of the foregoing, it is respectfully requested that each rejection of claims 1-11 (as amended) under 35 U.S.C. §112 be withdrawn.

Rejections Under 35 U.S.C. §102

The Office Action states that claims 1-6, 9, and 10 are rejected under 35 U.S.C.§102(b) as being anticipated by Okamura et al., U.S. Patent 5,373,046

("Okamura"). In reply, Applicants submit that Okamura does not anticipate the present invention, as recited in amended claims 1-11, for the reasons discussed below.

As the Examiner recognizes, Okamura discloses a process for producing a resin compound that can be molded into electronic parts. The process first involves melt-kneading a mixture comprising: (a) 40 to 90% by weight of polyethylene; (b) 10 to 40% by weight of conductive carbon black; and (c) if desired, not more than 20% by weight of talc. This carbon black masterbatch is then compounded with a thermoplastic engineering plastic and reinforcing fibers if desired. As the Examiner points out, Okamura discloses that polycarbonate and liquid crystalline polymers (LCPs) can be used as the thermoplastic, and PAN-type fiber prepared from polyacrylonitrile is a preferred reinforcing fiber because of its "excellent mechanical and dimensional characteristics." (col. 3, lines 42-45).

However, Okamura does not disclose a thermally-conductive, high tensile strength composition comprising all of the components recited in amended claim 1. Particularly, Okamura does not teach a thermally-conductive composition comprising: a) 30 to 70% of a base polymer matrix; b) 15 to 47% of high aspect PITCH-based carbon; c) 10 to 35% of high aspect PAN-based carbon; and d) 1 to 10% of a low aspect thermally-conductive filler. As further defined in claim 1, the composition has a thermal conductivity of at least 4 $W/m^{\circ}K$ and a tensile strength of at least 15 ksi.

It is submitted that Okamura does not disclose each and every element of amended claim 1 as required by an anticipatory reference. Accordingly, it is respectfully requested that the rejection of claims 1-6, 9, and 10 (as amended) under 35 U.S.C. §102(b) be withdrawn.

Rejections Under 35 U.S.C. §103

The Office Action states that in the alternative claims 1-6, 9, and 10 are rejected under 35 U.S.C.§103(a) as being obvious over Okamura. Applicants submit that the present invention, as recited in amended claims 1-11, is patentable over Okamura.

As discussed above, Applicants agree with the Examiner that Okamura discloses a composition containing a thermoplastic resin such as polycarbonate or a liquid crystalline polymer. Okamura teaches that the composition may be reinforced by the addition of PAN-type, glass, or potassium titanate fibers. However, Okamura fails to suggest a composition comprising a blend of high aspect PITCH-based and PAN-based carbon materials, and low aspect thermally-conductive filler material as recited in amended claim 1 of the instant application. Applicants have found that each of these components is significant, and the combination of these components provides the composition with many desirable properties.

For instance, the high aspect PAN-based carbon has high tensile strength and enhances the mechanical strength of the resulting composition. Particularly, PAN-based carbon fiber can have a tensile strength of greater than 30 ksi as discussed at Paragraph 34 in the specification. Secondly, the high aspect PITCH-based carbon and low aspect thermally-conductive filler are good thermal-conductors. Particularly, PITCH-based carbon flakes having a thermal-conductivity of 800 W/m°K and metallic or boron nitride fillers having a thermal-conductivity of 400 W/m°K can be used (Paragraphs 38 and 47). These filler materials make the resulting moldable composition thermally-conductive. As a result, the composition of the present invention can be molded into parts requiring high mechanical strength *and* heat-conductivity such as an outer casing for a cellular phone.

In contrast, Okamura is interested in making a resin compound containing carbon black that can be molded into parts for copier machines and other business equipment such as gears, rotary bearings, and guide rolls. There is clearly no suggestion for using high aspect PITCH-based carbon and low aspect thermally-conductive filler to impart high thermal conductivity to the composition. Rather, Okamura uses carbon-black and suggests that dispersing the carbon black uniformly in the polyethylene resin is critical.

> To the contrary, even with the composition being equal, where a resin compound is prepared by mixing all the components at the same time, the heat conductivity of the resulting molded article falls short because of the dispersed structure of carbon black, and the heat of friction is accumulated to cause great wear. (col. 10, lines 45-50).

In Okamura, the first step in the process for making the resin compound is preparing a mixture containing polyethylene and carbon black (col. 2, lines 1-66). Okamura does not suggest or hint at a blend containing high aspect PITCH-based and PAN-based carbon, and low aspect thermally-conductive filler materials as recited in amended claim 1. Thus, a person of ordinary skill in the art looking at the disclosure in Okamura would have no reason or basis for modifying the disclosure therein to produce the presently claimed invention.

Next, the Office Action states that claims 1 and 3-6 are rejected under 35 U.S.C.§103(a) as being obvious over Yamamoto et al., U.S. Patent 6,303,096 ("Yamamoto") in view of Okamura.

Yamamoto is directed to a pitch-based carbon fiber having high mechanical strength, tensile modulus and thermal-conductivity. Yamamoto suggests that his pitch-based carbon fiber is distinguishable from conventional pitch-based carbon fiber, because the spread La of graphite crystallites in the direction of layer plane is 1000 angstroms or less; the orientation angle in the direction of the fiber axis is 10° or less, and certain relationship formulas are satisfied (col. 2, lines 32-38). The fiber can generally be produced "according to a known method for producing a pitch based carbon fiber." (col. 3, lines 57-58).

As the Examiner points out, according to Yamamoto, it has been reported that pitch-based carbon fibers having a thermal conductivity exceeding 1000 W/m°K can be used in a heat-radiation plate in combination with PAN-based carbon fibers having a thermal conductivity of less than 200 W/m°K. (col. 1, lines 62-67 and col. 2, lines 1-4).

The Examiner takes the position that it would have been obvious to a person of ordinary skill in the art to use the blend of PITCH-based carbon fibers and PAN-based carbon fibers, as taught by Yamamoto, with the thermoplastic polymers taught by Okamura in order to produce the present invention.

However, Applicants submit that even if the teachings in Yamamoto and Okamura were combined, the present invention, as recited in amended claims 1-11, would still not be obvious to a person of ordinary skill in the art.

Although Yamamoto reports that a combination of PITCH-based and PAN-based carbon fibers has been used in a heat radiation plate, and Okamura discloses that a resin comprising a thermoplastic polymer and PAN-type carbon fibers can be prepared, neither reference teaches a composition comprising: a) 30 to 70% of a base polymer matrix; b) 15 to 47% of high aspect PITCH-based carbon; c) 10 to 35% of high aspect PAN-based carbon; and d) 1 to 10% of a low aspect thermally-conductive filler as recited in amended claim 1.

It is submitted that claim 1 (as amended) must be read in its entirety and each element of the claimed composition must be considered fully. The low aspect thermally-conductive filler material is important, because it helps to fill voids in the polymer matrix. Referring to Paragraph 45 in the specification, as the high aspect PITCH-based and PAN-based carbon materials are dispersed within the polymer matrix, voids are created between the dispersed materials. These open pores can negatively impact the thermal conductivity and mechanical strength of the polymer composition. But, Applicants have found that thermally-conductive materials having a low aspect ratio (less than 5:1) can be added to the composition in order to fill these voids, thereby enhancing the thermal conductivity of the composition. These materials can be selected from a wide variety of materials including boron nitride, aluminum, alumina, copper, magnesium, and brass as recited in dependent claim 11. Neither Yamamoto nor Okamura suggests a composition containing such low aspect thermally conductive materials.

It is respectfully submitted that in view of the teachings in Yamamoto and Okamura, a person of ordinary skill in the art could only construct Applicants' invention in hindsight based on Applicants' own specification and such a construction is impermissible.

As discussed above, Applicant believes that claim 1 (as amended) is in condition for allowance. Claims 3-11 are dependent on amended claim 1; thus, Applicant submits that these claims also are in condition for allowance.

In view of the foregoing, it is respectfully requested that the rejections of claims 1-6 and 9-10 (as amended) under 35 U.S.C. §103(a) be withdrawn.

Conclusion

In summary, Applicants submit that claims 1 and 3-11 (as amended) are patentable and each of the Examiner's rejections and objections has been overcome. Accordingly, Applicants respectfully request favorable consideration and allowance of amended claims 1 and 3-11.

The Commissioner is hereby authorized to charge any additional fee required in connection with the filing of this paper or credit any overpayment to Deposit Account 02-0900. Should there be any outstanding matter that needs to be resolved in the present application, the Examiner is invited to contact the undersigned at the telephone number provided below.

Respectfully submitted,

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